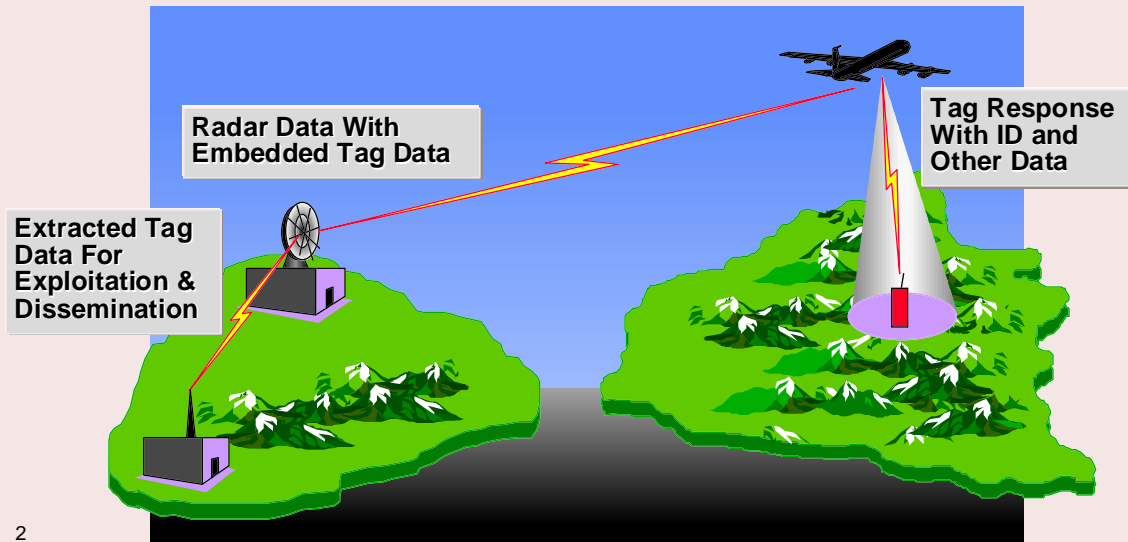# RF Tags

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PM RF TAGS

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1

RF Tags Vision

To Provide Ubiquitous LPI Communications Link
Throughout the Battlefield

Radar Data With Embedded Tag Data

Tag Response With ID and Other Data

Extracted Tag Data For Exploitation & Dissemination

2

The RF Tags program will develop low cost, miniaturized tags that can be used to communicate sensor data, still video, alerts and location data using MTI and SAR waveforms. This eliminates the need for long haul SATCOM or extensive radio communications links by using existing imagery data link infrastructure. The basic process is to have the airborne radar interrogate the tag, receive the tag response, extract the response from the imagery, and display the response. Responses could include sensor data, still video, alerts and location data.

Potential applications include (1) friendly situation awareness, (2) unattended ground sensor data link, (3) JSTARS target/track identification, (4) SAR imagery registration, and (5) treaty compliance verification.
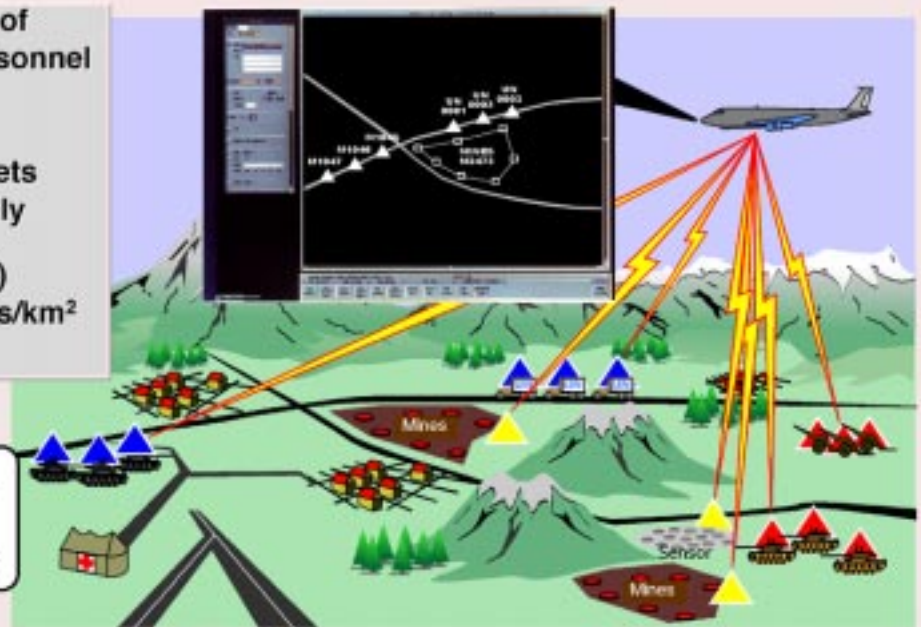
Situation awareness is an important tactical resource. Small, inexpensive tags could be carried by individual combatants, placed on their vehicles, used to mark mines, mine field boundaries and paths through mine fields, identify medical personnel, and identify critical friendly assets.   These tags will need to be small, low cost (<$300), difficult to detect by others, and be capable of being densely dispersed in the battlefield without generating self interference or interfering with other electronics equipment.

UGS Datalink

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Use: **Unattended ground sensor communications link**

Technical challenges:
Minimal platform impact

Data dissemination

LPD (Physical & RF)

Low Power

Link margin
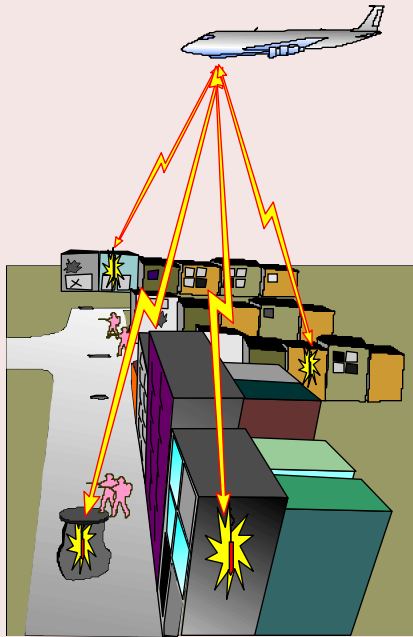
4

An RF Tag could be imbedded in an unattended ground sensor to provide a communications link from the sensor to a sensor data collection point. This would be accomplished by modulating the tag response to interrogations with the sensor data and extracting the data at the sensor data collection point.

JSTARS Target/Track ID System
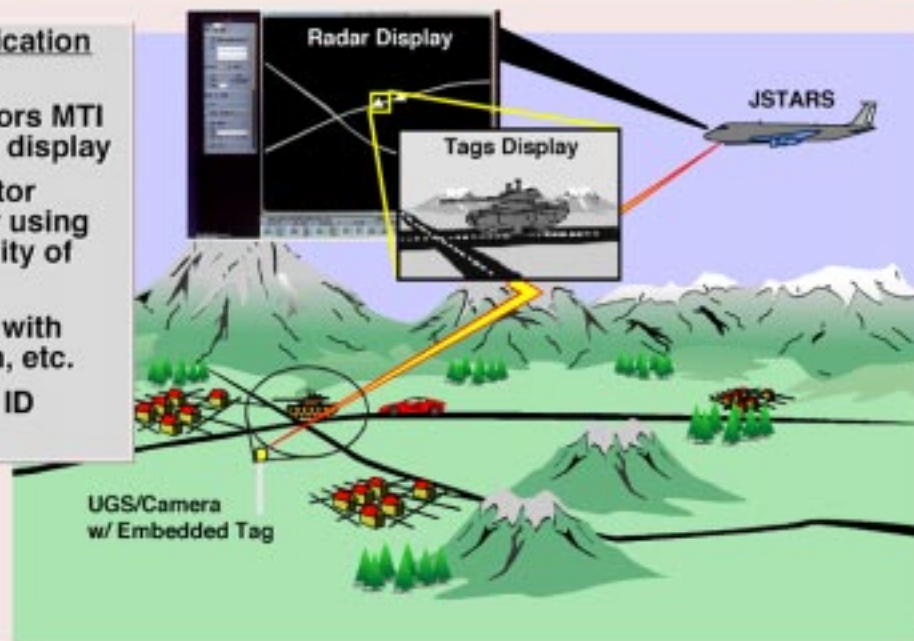
DARPA

Target Identification

JSTARS monitors MTI target on radar display

JSTARS operator queries sensor using RF Tag in vicinity of target

RF Tag replies with image, location, etc.

Gives JSTARS ID Capability

Radar Display

JSTARS

Tags Display

UGS/Camera w/ Embedded Tag

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RF Tags could assist JSTARS in monitoring and identifying unknown targets detected by its MTI radar. RF Tags with integrated small digital cameras or other sensors could be covertly placed at strategic road junctions, airfields and other tactically important locations. When an unknown track appears, the JSTARS operator can query one of these tags that is in the vicinity of the unknown track and receive identifying information. The operator can then change the track ID to reflect the correct identifier.
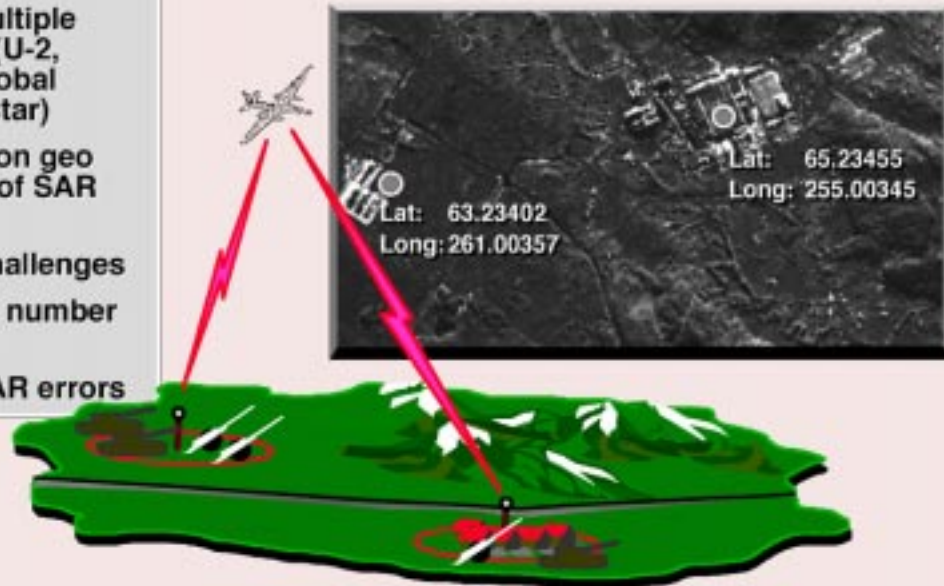
SAR Imagery Registration

Radar: TBD

Platform: Multiple Candidates (U-2, Predator, Global Hawk, Darkstar)

Use: Precision geo registration of SAR Imagery

Technical challenges

- Minimize number of tags

- Model SAR errors

Lat: 65.23455
Long: 255.00345

Lat: 63.23402
Long: 261.00357

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RF Tags can be used to register SAR imagery to obtain very precise geographic location information across the image. The tags would be emplaced in advance of the imagery collection mission. Their highly accurate position location could be used to automatically adjust the image to the precise coordinates.
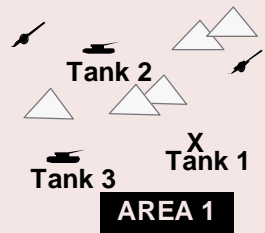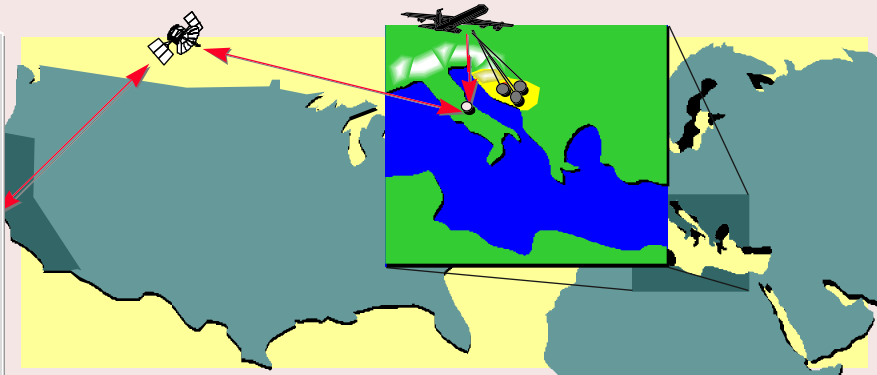
Treaty Compliance Verification

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Use: Monitor weapons systems for treaty verification

Very high reliability

High link margin

Minimal impact on other radar data

Cantonment /Status		Grid Coord	Other Data
ARTY	Out of Area	18098210	18098002
ARTY	√	18098272	
Tank 1	No Reply		
Tank 2	√		
Tank 3	Tamper	18098255	Low Battery
APC 1	√	18098255	

Tank 2

X Tank 1

Tank 3

AREA 1

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Another application for RF Tags is to verify treaty compliance. The tags could be attached to weapons or other military assets that are, by treaty, stored in specific locations.   Each tag would have a unique ID. A SAR equipped airborne platform would interrogate the tags periodically and report their location. The reported location would be compared to the storage location in a simple database file. Automatic reports would be generated that identify the status (OK, moved, no response, tamper, low battery, etc.) of the tag. The tags would be attached to the weapons such that if they were removed the tag would alter its response to indicate it had been tampered with.

RF Tags Technical Goals

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Tag Performance

	ID Tag	Low Data Rate	High Data Rate
Readout Rate	>100 tags/sec	>10 tags/sec	>one tag at a time
Cost/tag	< $300	<$1,000	<$3,000
Data/Query	>10 bits	>100 bits	>50 Kbs
Avg. Power	<.03 W	<.3 W	<3 W

High probability of detection (Pd > 0.9)

20 dB link margin at max range

Platform impact

- **Negligible SAR image impact (complex tag signal modulation)**
- **<25% load on MTI processing capability at max tag rate (efficient extraction algorithm)**
- **Platform integration (F-15, U2, JSTARS, Global Hawk, Darkstar, Predator, etc.)**

Signal
- **Number of tags**
- **Bits/tag**
- **Robustness (P_d, P_{fa}, P_{cc})**
- **Redundancy**
- **Message capability**
- **Speed (detection/decode)**

Hardware
- **Power/bit**
- **Transponder complexity**
- **SAR Processor speed complexity**

SAR Image
- **Detected/complex**
- **Pixels/bit (resolution)**
- **Clutter**
- **Sidelobe smearing**
- **Edge/truncation effects**
- **Clean/hide**
- **Subswaths**

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Technology goals are to develop RF Tags that (1) have sufficient link margin (20 dB over free space) to enable reliable communications in restrictive (urban, heavily forested and mountainous) environments, (2) provide high location accuracy to within 10 m without using GPS, (3) are robust to spoofing, jamming interception, and compromise, (4) provide a covert readout system for UGS, (5) provide tags to act as a SAR GPS registration beacon, (6) are scalable to 10,000+ users, (7) have extended battery lifetimes of 6 months or more depending upon application, and (8) cost less than $300/Tag in large quantities.

RF Tag goals will be accomplished by developing high efficiency, MIMIC based subsystems that generate replies to interrogations by various airborne radars. Replies will contain sensor data, still video, alerts, and location information which is processed in the airborne radar and sent to the appropriate user. Achievement of these goals will be demonstrated in a series of laboratory and field demonstrations.

Acquisition Strategy

Initial feasibility studies under way
- Proof-of-concept demonstration
- First order analysis

SAR/MTI signal processing
- Efficient code extraction
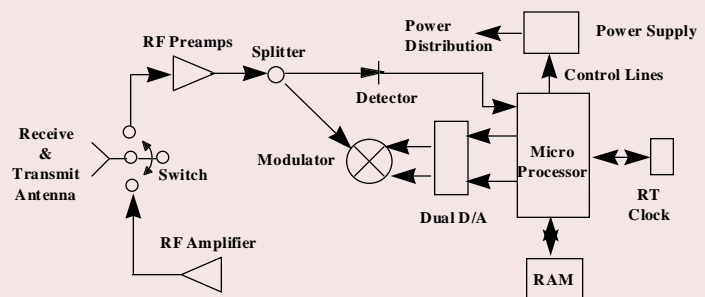- Minimum "cost" tag modulation
- Flight testing

Tag design
- Smaller antenna
- Lower power (>6 month lifetime)
- Security
- Multi-sensor

Operational platform/Conops studies
- Platform burden
- Ground station interfaces
- Data dissemination
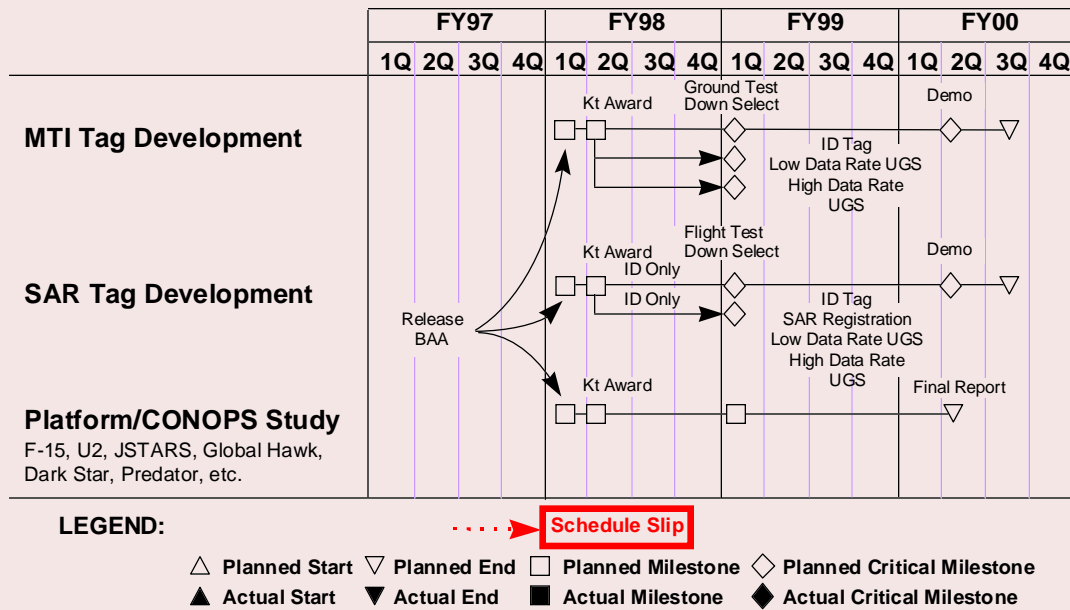- New missions

Approximately $15M over 3 years

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DARPA currently has contracts with Northrop Grumman, Sandia National Laboratory, Syracuse Research Corporation, and Environmental Research Institute of Michigan to conduct initial feasibility studies. Additional contracts are expected to be offered to industry.

Work will be performed to identify and develop efficient methods of imbedding and extracting tag data from SAR imagery without degrading imagery quality, reduce tag component costs, design and incorporate small, low profile antennas, reduce power consumption to extend tag operating life, and identify tag designs that work across multiple interrogator types/frequency bands. Several ground and airborne flight tests are planned. In addition, studies will be conducted to identify potential concepts of operation and airborne platforms. DARPA has budgeted approximately $15 million over the next three years for this effort.

Rf Tags Plan

	FY97				FY98				FY99				FY00			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q

MTI Tag Development

Kt Award — Ground Test Down Select — Demo
ID Tag
Low Data Rate UGS
High Data Rate UGS

SAR Tag Development

Release BAA
Kt Award — Flight Test Down Select — Demo
ID Only
ID Only
ID Tag
SAR Registration
Low Data Rate UGS
High Data Rate UGS

Platform/CONOPS Study
F-15, U2, JSTARS, Global Hawk,
Dark Star, Predator, etc.

Kt Award — Final Report

LEGEND: · · · · ▶ **Schedule Slip**

△ **Planned Start** ▽ **Planned End** □ **Planned Milestone** ◇ **Planned Critical Milestone**
▲ **Actual Start** ▼ **Actual End** ■ **Actual Milestone** ◆ **Actual Critical Milestone**

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DARPA plans to issue a Broad Area Announcement (BAA) in 1st Quarter FY98 for various scientific work related to SAR and MTI tag development, as well as CONOPS and airborne platform studies. Multiple contract awards are expected. Ground and flight tests are planned for 1st Quarter FY99. The most promising efforts will be continued to fabricate and demonstrate fully integrated tag systems in FY00.